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NOTES ON A NEW INFUSORIAN.

BY DR. ALFRED C. STOKES.

EARLY in the spring of last year (1883), I gathered a quantity of Lemna from a pond whose surface was so completely covered by the little plants that they seemed to be jostling each other for growing room. The water beneath must have been quite dark, being lighted probably only by so much of a faint green glimmering of sunbeams as the Lemna could transmit, yet that shallow pond contained myriads of living creatures. For eight months or longer the gathering has stood neglected upon my table, a little fresh water being occasionally added to supply that lost by evaporation, and it is still clear and untainted, although every frond has lost its rootlets, and the greater number have gone to decay, and though many generations of Infusoria, rotifers and Turbellarian worms have come and gone, and added their little to the residual detritus covering the bottom of the vessel. The Infusoria, therefore, now living within the restricted habitat of this glass saucer cannot be considered as Infusoria of putrid waters, and those recently appearing there in midwinter are probably from germs forced into development by a kind of hot-house process in a warm room. The same forms might be taken in season from the original pond itself. They seem, however, to have hitherto escaped observation, and as they possess structural peculiarities which, so far as the writer can learn, are limited to their own little bodies, it is necessary to erect not only a new species for their reception, but a new genus.

The body of the Infusorian, which I have named *Ctedoctema acanthocrypta*, gen. et sp. nov., is soft and flexible, but persistent in shape, its form being elongate-ovate, subcylindrical and slightly compressed, widest and rounded posteriorly, thence tapering evenly to the obtuse mesially placed anterior point. The entire cuticular surface is ciliated, the cilia being long and fine, their length often exceeding the short diameter of the body. They are arranged in rows that are more distinctly seriate on the dorsal aspect. Ventrally their arrangement is more irregular, and here they seem to be constantly in motion. All are flexible and all are at times put into vibration, but each individual filament upon the lateral and dorsal surfaces is capable of independent movement. When their tips are focussed, scattered cilia are seen to tap and patter against the cover-glass, and the four or five stiffer, more setose hairs projecting from the posterior extremity quiver and occasionally lash the water as if the animal had hardly time to eat. One of these postero-terminal cilia has its distal extremity conspicuously curved, as is shown in the figures. When the infusorian is at rest, the cuticular cilia, with the exception of those on the ventral aspect, do not vibrate, but stand out from the surface like long bristles; at such times the only additional actively moving cilia are those of the oral series and a single row on the left lateral body margin. As the creature is rapidly swimming, to distinguish whether any or all of the cilia are in motion is next to impossible. It is only during the moments preceding death by iodine poisoning that the question can be answered, as it is in the affirmative, not a cilium then being idle.

In its movements the creature is wonderfully swift, darting across the field so quickly that the looker-on can only see that something has passed by. Even when a pleasant feeding ground is discovered under the lee of an algous filament or a patch of dirt, the lively animal cannot rest, but at frequent and almost regular intervals darts forward for one-half its length and as quickly slips back to its former position. In this rhythmic swing it seems to use the tips of the supporting cilia as fulcra, thus converting itself into an animated lever of the third class, where the power is between the weight and the pivot.

In Fig. 1 Ctedoctema is represented in its dorsal aspect, drawn with the camera lucida and magnified 700 diameters. Its extreme length is $\frac{1}{1000}$ inch. The nucleus, as shown in the figure, is ovate, and situated about mesially in the anterior body half. The pulsating vacuole, sub-terminally located below and to the right of the median line, contracts at intervals of six seconds.

The infusorian has the inexplicable habit of protruding subterminally on the left dorso-lateral margin, a colorless, semi-transparent hemisphere of the body sarcode, in which there is often a circulation of the minutely granulate protoplasm. The object of this bubble-like protrusion, as intimated, I have been unable to determine. It was at first mistaken for the beginning of a temporary anal aperture, but such use of it has not been observed. It is frequently withdrawn, leaving a lighter smooth spot in its place.

But it is on the ventral surface that we find most of the creature's peculiarities. Originating at the anterior margin and extending almost centrally across the ventral surface, but somewhat obliquely backward and inward, for a distance equal to three-fourths of the animal's entire length, is a shallow, narrowly ovate groove, at whose posterior and widest and deepest part the oral aperture is placed. This depression, narrowest at its anterior origin and gradually and regularly widening to its rounded posterior termination, is clothed with long fine cilia for about two-thirds of its length. The longest of these vibratile hairs are in length nearly equal to the animal's transverse diameter, being longest and somewhat fasciculately clustered on the extreme anterior margin, thence becoming gradually shorter until about two-thirds of the groove are supplied. They seem to be absent from the remainder of the depression with the exception of the space immediately around the oral aperture, where they are visible only in their effect and in the peculiar glimmering appearance which they produce, that shimmering of the surface like the wavering of heated

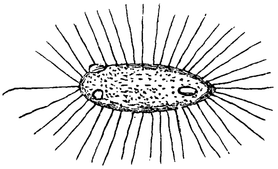

Fig. 1.

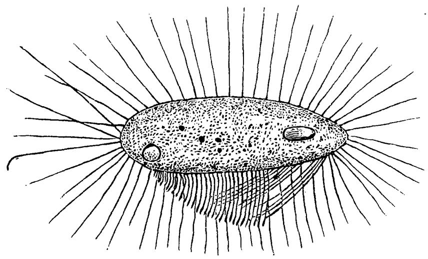

Fig. 2.

FIG. 1.—*Ctedoctema acanthocrypta*, gen. et sp. nov. Dorsal aspect. × 700. FIG. 2.—Lateral aspect.

air which one so soon learns to associate with the action of fine cilia. When the animal is swimming, those anteriorly placed are snugly packed away longitudinally in the adoral groove. Occasionally they are quiescent long enough at other times to exhibit their length and tufted arrangement, when they are held arcuately parallel with and below the adoral depression.

Near the left hand margin of this elongated sinus is a single row of long fine vibratile cilia, whose points of attachment are much more widely separated than those on the general cuticular surface. Their vibrations seem to be at right angles to the course of the adoral groove, but the facility with which the direction of movement in such delicate filaments may be misinterpreted is remarkable. After those intervals, few and far between and at best of but momentary duration, when they become quiet and visible, their action certainly seems to be renewed, and they to fade from view, as the animal lies upon its side, not by a lateral sweep but by a downward flashing of the whole series; that such is the fact, however, I am not prepared to say; it only seems so.

Attached to the right margin of the adoral sinus is a symphony in cilia which, so far as I am aware, is possessed by no other infusorian. It is really musical in the beauty and the harmony of its arrangement. The ciliary constituents of this delightfully satisfactory series are each much coarser and stouter than any others on the creature. Placed in a single row and slightly curving over the adoral depression, they begin anteriorly at a distance from the frontal margin equal to about one-third of the entire length of the groove, the first and foremost cilium being scarcely shorter than the animal's transverse diameter, the length of each succeeding one becoming a little less than the preceding, until the last just rises above the surface immediately behind and somewhat to the left side of the oral aperture. Each member of this comb-like appendage not only curves in accordance with the regular curvature of the series, but has a distinct thickening of its distal extremity whereby that free end is brought into apparent contact with its neighbor. Under insufficient magnifying power this state of affairs presents the aspect of a long curved posteriorly originating flagellum, or the lowermost outline of an adoral hood; and when thus examined the animal presents a striking resemblance to Pleuronema or Cyclidium. Indeed, we have only to imagine the former as having divided its hood-like velum longitudinally and split up each moiety into transverse filaments, when the resultant creature would bear a strong likeness to Ctedoctema, and would probably be relegated to the same genus. As it is, the observer must be in some doubt as to the ordinal position of Ctedoctema. Does it, in common with Cyclidium and Uronema, belong to the Ciliata-Holotricha, or to the Ciliata-Heterotricha? The boundary between the two orders is so indistinctly defined that the doubt becomes a serious one.

However, the cilia which have led me into this side issue remain standing, like the sentinels they are, beside the adoral sinus. While the animal is feeding they are not actively vibratile, although the whole row has the power of bending in a body across the groove. I have seen them waving back and forth in an unbroken line like an animated comb. Each member of the group also has the ability of separately bending in a direction away from the median line, and it uses this accomplishment when a food-particle, too large or otherwise unacceptable, must be discarded, several often flirting themselves in unison outwardly when there is too great an accumulation about the oral aperture. When their possessor is swimming they are drawn up against the ventral surface parallel with the margin of the adoral groove, and consequently in contact with each other, their free ends thus pointing posteriorly.

I have found it quite impossible to use the camera lucida in drawing the details of these active little animals. The figures are therefore more or less diagrammatic, with the exception of the first. In the second (Fig. 2) an attempt is made to show the animal in its lateral aspect, with the coarse comb of adoral cilia, the anterior ciliary tuft and the single row of long, laterally-disposed vibratile hairs, as well as the nucleus and the contractile vesicle. In Fig. 3 Ctedoctema exhibits its ventral surface, especially the adoral groove, with the ciliary comb on its margin, laterally curved above it and surrounding its termination posteriorly.

The trichocysts, found, it is said, only in the flesh of members of the Ciliata, are numerous in Ctedoctema, huge in proportion to the size of the infusorian, and possessed of peculiarities not hitherto noticed in connection with those of any other member of the class. The action of the recently-recommended solution of tannic acid in glycerine for the purpose of rendering trichocysts conspicuous, is eminently successful and satisfactory.

When killed by this mixture, Ctedoctema becomes a nondescript object, woolly with distorted cilia, and having trichocysts like great darning-needles projecting from various parts of the surface. They are occasionally so violently extruded that they leave the body and fall away free. The infusorian is $\frac{1}{1000}$ inch in length; the trichocysts are $\frac{1}{2000}$ inch long, precisely one-half Ctedoctema's greatest length, and but a fraction shorter than its transverse diameter. Under suitable amplification they are visible within the living animal. Those of the posterior extremity are arranged nearly parallel with the median line; those of the posterior body half are directed forward, those of the anterior half backward, toward the center of the creature. They are rigid and straight, and, for their length, coarse and stout. They project slightly beyond the cuticular surface and often give the infusorian, in optical section, a minutely crenated outline. Although so skewered the body is still soft and flexible.

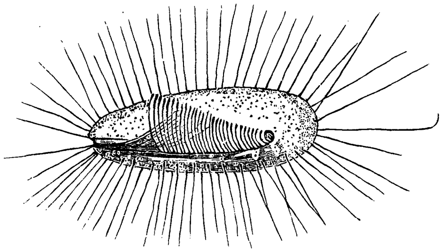

Fig. 3.

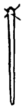

Fig. 4.

FIG. 3.—*Ctedoctema acanthocrypta*, ventral aspect. FIG. 4.—Trichocyst with radiating processes.

From their distal end they taper evenly to an obtuse point, and seem to be prismatic. The structural parts which I think have hitherto not been noticed with those of any other infusorian, consist of four, occasionally of only two linear processes radiating from the body of the trichocyst, like the finger-boards on the sign-posts at country cross-roads, as shown in Fig. 4. These projecting filaments, measuring $\frac{1}{10000}$ inch in length, are of extreme delicacy, and take their origin at a distance about equal to one-half their length below the distal extremity of the trichocyst. Their direction is not always at right angles to their support, but frequently, even in those of the same individual, they project upward or downward, or form angles of various degrees.

The oral aperture is not followed by a distinct pharyngeal passage, and although I have never observed food-particles enter, yet judging from the presence within the sarcode of small green corpuscles, which I have taken to be of vegetable origin, I suppose Ctedoctema is a vegetarian. Neither has an anal opening been distinctly noticed. Upon several occasions what has appeared to be an extrusion of excrementitious matters has taken place posteriorly to the oral aperture and back of the ciliary comb, but the flow of rejected food-particles brought by the adoral currents is so great and so constant, that the question is still an open one.

As to the fashion of its reproduction: Is it as whimsical in its manner of renewing its youth as in its adoral anatomy? In one respect, yes. In one respect it goes about that business in a way to surprise the on-looker who has become familiar with every style of fission and with several varieties of cystic sacs, and in a way, too, that makes him pause a moment to admire the exhaustless resources of a divine mind.

That reproduction is by transverse fission goes without saying. But if only that, imagine, if you can, what becomes of all the complex ciliary arrangement about the oral region. The creature to be fashioned from the posterior half of the mature body must have not only a ciliated adoral sinus and the comb-like appendage, all of which simple division crosswise would give, but it must somehow obtain that ciliary fascicle at the anterior apex of that sinus. The posterior termination of the old Ctedoctema's groove has no such tuft to give the new creature, and the latter cannot, at least does not, exude sarcode filaments that shall stiffen into cilia. Then, when and how? Oh, it is so simple and so easy when it is once thought of! But no one ever would think of it without seeing it.

It is in this way: The cilia of that comb deliberately unite laterally and form a membrane. The anterior cilia of the sinus unite with it and lengthen the membrane to the front, the newly-formed tissue being widest somewhat in advance of its center, and narrowing toward both ends. The animal then separates across the middle, forming two Holotrichous creatures, each with a perfectly smooth, unwrinkled membrane vibrating somewhat obliquely along the center of its ventral surface, the free edge of this tip-tilting tissue being distinctly and strongly thickened. What scheme of classification has a place for them now? If they and the systematist should have a temporary encounter, what would he do with them? Would each be a fresh-water Lembus? Such questions give them no trouble. They at once proceed to form their ciliary appendages[5] by splitting up their membrane to suit. The fringes unite to form the membrane, the membrane divides to form the fringes, the thick edge then going into the thickened extremities of the adoral comb. In two hours, more or less, the sweet-water Lembus is a sweet-water Ctedoctema, of which the following may be taken as a description:

Ctedoctema, gen. nov. (Greek, *ktedon*, a comb; *ktema*, a possession).—Animalcules free-swimming, more or less ovate, persistent in shape, entirely ciliate; oral cilia diverse to those of the cuticular surface; oral aperture ventral, located at the posterior termination of a longitudinal, ciliated, adoral depression or groove which bears on its right-hand border a row of large arcutely curved setose cilia gradually diminishing in length toward the oral aperture, which they surround, and with their distal extremities conspicuously thickened; several long, setose hairs projecting from the posterior extremity of the body, usually a single one being distally curved; contractile vesicle single, posteriorly placed; trichocysts large and numerous.

C. acanthocrypta, sp. nov. (Greek, *akantha*, spine; *kruptos*, concealed).—Body elongate-ovate, widest and rounded posteriorly, tapering to an obtuse anterior apex, subcylindrical, slightly compressed, the length twice to two and one-half times the breadth, a hemispherical sarcode bubble usually present on the left hand dorso-lateral border; cuticular cilia long, fine, setose, a single postero-terminal seta usually distally curved; oral aperture ciliated, remote from the anterior apex, placed at the posterior termination of a shallow, narrowly ovate, ciliated, adoral groove centrally and longitudinally traversing three-fourths of the ventral surface, and bearing on its right hand margin a flexible comb-like appendage composed of large, coarse, non-vibratile cilia, thickened distally and diminishing in length as they approach the oral aperture, which they surround; the adoral groove also bearing near its left hand margin a row of long, fine, vibratile hairs, and throughout its entire length a series of long, vibratile cilia, somewhat fascicled anteriorly and shortening as they approach the mouth; contractile vesicle single, sub-terminally located near the right border; nucleus ovate, mesially placed in the anterior body half; trichocysts large, straight, apparently prismatic, tapering to an obtuse point, and bearing distally two or more minute, radiating, linear processes. Habitat: Fresh water, with Lemna. Length of body $\frac{1}{1000}$ inch.

The animal was studied with a homogeneous immersion $\frac{1}{10}$ by Herbert Spencer, N. A. 1.35, and a homogeneous immersion $\frac{1}{8}$ by Bausch and Lomb, N. A. 1.43, two objectives which are really works of art.